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## RESEARCH NOTE

# MULTI-SPECIES AGGREGATIONS IN NEOTROPICAL HARVESTMEN (OPILIONES, GONYLEPTIDAE)

Harvestmen are generally vagile and solitary but some species may be found in stationary aggregations. Gregariousness in harvestmen has been recorded in some Palpatores (Cockerill 1988 and incl. ref.; Coddington et al. 1990; Holmberg et al. 1984) and Laniatores species (Capocasale & Bruno-Trezza 1964; Acosta et al. 1993; Pinto-da-Rocha 1993). Multi-species aggregations have been reported once for three Leiobuninae species (Palpatores) in the southern USA (Cockerill 1988).

On 3 and 16 November 1996, multi-species aggregations of harvestmen were found in the low vegetation in a swampy area of Serra do Cipó (19°17′S, 43°35′W, 1200 m elevation), Minas Gerais State, Brazil. The local vegetation consists of Montane Fields ("campo rupestre"): mainly shrubs and low herbs growing in thin and rocky soil. Water infiltration into the ground was retarded by the layers below the thin soil. As a result, with any minor rainfall, the whole area became a swamp (Joly 1970). We sampled a 460 $m^2$ plot in a swamp in the early afternoon. All harvestmen found were collected and immediately preserved in 70% ethanol. During the survey we also observed the behavioral responses of the individuals to disturbance (such as attempts to escape, immobility, discharge of odorous secretions). Voucher specimens were deposited in the arachnological collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP).

Harvestmen were found either in clumps of roots of gramineous species, or partially buried in the mud below these clumps. The soil in the basal portion of clumps was still muddy but not saturated to the point that pools of water were still present. We found 93 individuals belonging to three species of the family Gonyleptidae: *Despirus montanus* Mello-Leitão 1941 (subfamily Mitobatinae), *Eugyndes* sp. (a new species of the subfamily Pachylinae) and *Holoversia nigra* Mello-Leitão 1940 (subfamily Gonyleptinae). Nine individuals (9.7%) were found isolated, not associated with any aggregation: four *D. montanus* (1♂3♀), three *Eugyndes* sp. (1♂2♀) and two *H. nigra* (1♂1♀). The remaining 84 individuals (90.7%) were found in five multi-species aggregations. The average number of individuals per cluster was 16.8 (SD = 11.1; range 5–34; $n = 5$). *Despirus montanus* and *Eugyndes* sp. were the most commonly encountered species in the aggregations since 95.2% of the individuals in all aggregates belonged to these species (Table 1). In both species, the sex ratio was not significantly different from 1:1 (*D. montanus* — $\chi^2 = 2.38$; *Eugyndes* sp. — $\chi^2 = 1.68$; $df = 1$; $P > 0.05$). *Holoversia nigra* was present in three aggregations and represented by only a few individuals—generally one or two per aggregation. The two isolated individuals of this species were found in the swamp area at distances of 1 and 2 m from the nearest aggregation where this species was not found. Table 1 shows the occurrence of species within aggregates.

When the aggregated individuals were disturbed, it appeared that only *H. nigra* released repugnatory substances. After the discharge, the individuals of this species abandoned the aggregations slowly. Disturbed individuals of *D. montanus* and *Eugyndes* sp. fled the place of disturbance or hid themselves in the base of the root clumps. Even when these species were manipulated they did not release detectable defensive secretions. Some laniatorid species use their repugnatory substances very sparingly, if at all (see Cokendolpher 1987; Roach et al. 1980).

Even though the water had receded at least one night before the harvestmen were found, they were still aggregated. Thus we reject the hypothesis that the harvestmen had aggregated in the root clumps to avoid drowning and had not had time to disperse. Gregarious be-

Table 1.—Species occurrence within five different multi-species aggregations of 84 harvestmen in a swamp in Serra do Cipó, Minas Gerais State, Brazil.

| *Holoversia nigra* | | *Eugyndes* sp. | | *Despirus montanus* | | Total # of individuals |
|---|---|---|---|---|---|---|
| Male | Female | Male | Female | Male | Female | |
| 0 | 1 | 1 | 1 | 1 | 1 | 5 |
| 1 | 0 | 1 | 1 | 3 | 4 | 10 |
| 0 | 0 | 6 | 3 | 1 | 5 | 15 |
| 1 | 1 | 8 | 6 | 2 | 2 | 20 |
| 0 | 0 | 7 | 4 | 9 | 14 | 34 |
| 4.8% | | 45.2% | | 50.0% | | 84 |

havior in harvestmen has been interpreted in several ways according to Holmberg et al. 1984. The first interpretation is that the aggregations are formed in optimal places in order to avoid dehydration and exposure to light. The risk of dehydration must be low in the basal portion of the gramineous clump, since this microhabitat is constantly moist. Besides, all swamp area was under similar light conditions and the aggregation places were not patches of darkened areas. Thus the microhabitat explanation is not adequate to explain why the aggregations are formed in very different locations in the swamp. We can not reject the hypothesis, however, that multi-species aggregations are formed in more protected areas (due to greater interpenetration of the grass roots, for example) and thereby serve as hiding places from predators.

Another hypothesis is that the gregarious behavior increases the defensive ability against predators by the collective action of the repulsive substances secreted by these animals. This hypothesis may be supported by the fact that disturbance of an aggregate is immediately followed by a discharge of a substance with a strong, sour smell, produced by at least one species of harvestmen. Thus the multi-species aggregations of harvestmen may rely on the fact that the non-chemically protected species (i.e., those species which rarely released these chemicals: *D. montanus* and *Eugyndes* sp.) may get protection from aggregating with chemically-protected species (*H. nigra*). On the other hand, harvestmen that secrete noxious chemicals may gain benefit from the presence of non-secreting harvestmen, by the dilution effect (*sensu* Krebs & Davies 1993; see also Calvert et al. 1979; Duncan & Vigne 1979; Foster & Treherne 1981). By living in groups, the chemically-protected species may diminish the risk of being preyed upon because there are more chances that another individual be the victim. Although *H. nigra* was not found in all clusters, it is possible that it was present in the formation of the aggregation. Both *D. montanus* and *Eugyndes* sp. showed a tendency to aggregate, and individuals found isolated may temporarily have moved away from aggregations or have been expelled by other individuals of the group. Capocasale & Bruno-Trezza (1964) suggested that the expulsion of conspecifics from clusters was the reason why isolated individuals were found in *Acanthopachylus aculeatus* (Kirby 1818), but the reasons for this were not stated in that work.

Even if mating groups could be one of the reasons to the formation of mono-species aggregations (Holmberg et al. 1984), other effects like dilution and chemical protection could result in the incorporation of additional species to this groups. In the future, experimental studies should be performed in order to understand the evolutionary significance of gregarious behavior in harvestman.

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